Clinical Medicine

Postdefibrillation Idioventricular Rhythm—A Salvageable Condition

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While patients who present with a pulseless idioventricular rhythm have a dismal prognosis, such a rhythm following electrical defibrillation from ventricular fibrillation (VF) may have an entirely different clinical significance. By reviewing the cases of 100 consecutive patients with prehospital ventricular fibrillation, we found the following: Subsequent development of field pulses, survival to hospital admission and hospital discharge in 49 patients who initially had pulseless idioventricular rhythm following defibrillation were statistically significantly worse ($P < .05$) than for 20 patients successfully defibrillated into any other organized rhythm. They were statistically significantly better, however, than for 25 patients who failed to achieve any organized rhythm in the field. Outcomes were statistically no different in 40 patients who received standard advanced cardiac life support drug therapy for pulseless idioventricular rhythm after defibrillation than in 9 patients who spontaneously progressed to another rhythm before drug therapy could be given. These findings suggest that pulseless idioventricular rhythm may be a transient recovery rhythm following defibrillation from prehospital VF, that it can in this circumstance be associated with a good outcome in a reasonable number of patients and that a short trial of cardiopulmonary resuscitation only, without immediate drug therapy, may be appropriate in these patients.

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Idioventricular rhythm is generally considered an almost uniformly nonviable rhythm in patients with cardiac arrest. While it is true that almost all survivors of cardiac arrest present with ventricular tachycardia or ventricular fibrillation (VF) and that patients presenting with any other rhythm, including idioventricular rhythm, asystole, severe bradycardia or electromechanical dissociation (EMD), have a dismal prognosis,[1-3] the development of one or more of these rhythms following defibrillation from VF may have an entirely different significance. We reviewed all recorded tapes and typed manuscripts of these tapes for patients with prehospital VF treated by paramedics under the direction of the UCLA base station during a 19-month period to determine the prognostic significance of rhythms seen subsequent to successful defibrillation from VF. We evaluated as well the relationship between outcome and specific mode of therapy for postdefibrillation idioventricular rhythm. We postulated that the development of an idioventricular rhythm immediately following defibrillation represents a transient recovery rhythm that can in some cases spontaneously improve, leading to the appearance of pulses, supraventricular activity, stabilization of hemodynamic status and possible long-term survival.

Materials and Methods

UCLA Medical Center is a 750-bed acute care hospital that serves as a paramedic base hospital in the west Los Angeles region. Paramedic radio calls are supervised at the UCLA base station by a physician or mobile intensive care nurse (MICN). Base station physicians are UCLA residents or faculty who have successfully completed the advanced cardiac life support course of the American Heart Association and the base station physician's course of the American College of Emergency Physicians. MICNs are registered nurses specially trained and certified to answer paramedic radio calls. Base station contact is mandatory for all cases of cardiac arrest. Cardiac patients receive prehospital care and are then transported to one of seven receiving hospitals. Continuous tape recordings are made of all radio communications, and written records, including electrocardiographic monitor strips when appropriate, are kept for all cases. During the time of this study, paramedics were authorized to secure an airway with an esophageal obturator airway and to defibrillate before establishing base station radio contact. They could carry out base station orders to place an intravenous catheter and to administer standard drugs, including but not limited to epinephrine, atropine, isoproterenol hydrochloride, calcium chloride, sodium bicarbonate, lidocaine and bretylium tosylate.

We reviewed 104 consecutive paramedic radio calls to the UCLA base station from January 1980 to August 1981 in which patients with prehospital cardiac arrest had an initial rhythm of ventricular fibrillation. Four patients with VF following drowning, electrocution or traumatic injury were ex-

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ABBREVIATIONS USED IN TEXT

EMD = electromechanical dissociation
MICN = mobile intensive care nurse
VF = ventricular fibrillation

cluded. Six patients were excluded because their subsequent arrival at an emergency department could not be documented. This left 94 study patients, for all of whom data were collected by reviewing all tape recordings in their entirety and all written records for each case. An idioventricular rhythm response to defibrillation, the development of subsequent cardiac rhythms and the presence or absence of pulses in the prehospital setting were documented. Precise data were frequently not available regarding the time of unresponsiveness, although tapes and rhythm report forms were carefully reviewed in an attempt to ascertain certain information. The usual response time of paramedic units was from three to ten minutes, but specific times were poorly documented. Patient rhythms were successfully telemetered in about a third of cases, and rhythms were otherwise interpreted by the paramedics at the scene. For the purposes of this article, we defined an organized cardiac rhythm as any electrical activity other than ventricular fibrillation or asystole. Idioventricular rhythm was defined as an organized cardiac rhythm with wide complexes appearing at a rate of less than 60 times per minute, without visible P waves. When such wide complexes occurred sporadically at a rate of less than ten times per minute, the rhythm was considered agonal and described as asystole. Wide QRS-complex rhythms at a rate greater than 100 times per minute were considered to represent ventricular tachycardia, whereas wide QRS-complex rhythms occurring at a rate between 60 and 100 times per minute were classified as "other ventricular rhythms." Palpable pulses were considered present when the paramedics were able to palpate carotid or femoral pulses, which they endeavored to do following any attempt at defibrillation, immediately following any change in cardiac rhythm and every two to four minutes during an organized cardiac rhythm.

Prehospital therapy for ventricular fibrillation was based on standard protocols, although variations in therapy were ordered at the discretion of the base station physician or MICN. In most cases of cardiac arrest with a presenting rhythm of VF, paramedics initiated therapy with countershock at 400 watt seconds of stored energy, which was the amount of energy recommended in the standard American Heart Association protocol at the time of the study. In several cases, however, sodium bicarbonate or epinephrine (or both) was administered intravenously through a catheter before the first countershock. When field stabilization—defined as the establishment of a consistent palpable pulse—was achieved, patients were transported to the closest of seven receiving hospitals. Patients who remained pulseless or who became pulseless again following the development of a transient palpable pulse were treated according to standard algorithms and were transported at the discretion of the base station or MICN only when a trial of drug therapy produced no apparent effect. Admissions to hospitals were identified from emergency department records. Discharge from hospital alive or in-hospital death was determined from patient hospital records.

We defined outcomes in terms of the development of pulses and hospital admission, as well as survival to hospital discharge. While hospital discharge is clearly the most important "successful" outcome, we also looked at the other two intermediate outcomes and considered them at least partially "successful" responses to therapy, as they may predict increased likelihood of survival to hospital discharge if subsequent interventions are optimal.

Statistical comparisons of noncontinuous data were made by Fisher's exact test; we considered a P value of less than .05 as statistically significant.

Results

Of 94 patients included in the series, 69 had the development of organized rhythm at some point during the prehospital phase, while 25 did not. Outcome was dismal for patients in whom an organized rhythm did not develop (no patient discharged alive), as it was for patients in whom an organized rhythm, but not a pulse, developed in the field (no one discharged alive). Of the 69 patients who ultimately had an organized rhythm develop, survival was significantly better in the 57 patients responding to the first two countershocks (16%) than in those 12 patients in whom a rhythm developed only after multiple countershocks (one long-term survivor).[4]

The initial heart rate associated with the first organized rhythm was documented in 69 patients (Table 1). Patients with bradycardia had significantly poorer survival to hospital admission and discharge than patients whose initial heart rate equaled or exceeded 60 beats per minute; nevertheless, 27 (50%) of the patients with bradycardia achieved pulses in the field, 15 (28%) were admitted to hospital and 5 (9%) survived. These numbers are comparable to those for the initial cohort of 94 patients with VF as a whole, of whom 40% (38 patients) achieved pulses in the field, 26% (24) were admitted and 11% (10) were discharged alive.

Of the 69 patients in whom an organized rhythm developed, a good outcome could be achieved regardless of the specific nature of that initial rhythm (Table 2). While outcome was statistically worse when the initial postdefibrillation rhythm was idioventricular (49 patients) than with other rhythms, a pulse developed at one point during the resuscitation of 47% of patients with this rhythm, 27% were admitted to the hospital alive and 8% were discharged from the hospital alive. These numbers were not statistically different from those of the original cohort with VF and are far better than the results for patients failing to have any organized rhythm in the field (Table 2).

The large majority of patients in whom idioventricular rhythm developed were initially pulseless at the time this rhythm occurred; only 3 patients with such a rhythm following defibrillation had a pulse at the time this rhythm appeared, whereas 46 patients had an initially pulseless rhythm.

TABLE 1.—*Outcome Related to Initial Postdefibrillation Heart Rate in 69 Patients With an Organized Rhythm**

Heart Rate, Beats/min	Patients, No.	Outcome: Eventual Pulses in the Field, No. (%)	Outcome: Admitted, No. (%)	Outcome: Discharged Alive, No. (%)
<60 . . .	54	27(50)	15(28)	5(9)
≥60 . . .	15	11(73)	8(53)	5(33)
Totals . . .	69	38(55)	23(33)	10(14)
P		NS	<.01	<.01

NS = no significance

*An organized rhythm is any rhythm other than ventricular fibrillation or asystole.

While none of the 3 patients with pulses accompanying their initial idioventricular rhythm were either admitted to hospital or survived to discharge, 18 patients with such a rhythm who initially were pulseless subsequently had a pulse during the prehospital resuscitation, 15 were admitted to hospital alive and 4 were discharged alive. Of these patients, 13 first had the development of pulses at a time when they remained in an idioventricular rhythm.

Subsequent rhythm evolution and drug therapy during idioventricular rhythm were evaluated in the 49 patients who had such a rhythm immediately following defibrillation (Tables 3 and 4). Patients with persistent idioventricular rhythm throughout their prehospital course were not statistically different from the entire group, while 19 patients with this rhythm degenerating to recurrent VF less frequently achieved pulses or hospital admission and showed a trend toward a poorer outcome with regard to hospital discharge, although this latter difference did not reach statistical significance because of the small numbers involved (Table 3).

We do not have information regarding the timing of subsequent therapy for patients in whom postdefibrillation idioventricular rhythm developed, and thus we cannot say how long therapy was withheld following the development of the rhythm. We do have information, however, as to what types of therapy were given to patients with this rhythm before any other rhythm developed (Table 4). In the small number of patients (nine) who received no therapy, the idioventricular rhythm either spontaneously reverted to VF (3 patients, in whom there was no survival) or spontaneously converted to a perfusing rhythm (six patients) with palpable pulses; five of these latter patients were admitted, with one surviving to hospital discharge.

There was a trend toward worse outcome by all measurements for the much larger number of patients who received drug therapy; this reached statistical significance ($P < .05$) only with regard to hospital admission. In addition, a similar but slightly greater proportion of patients receiving drugs had recurrent VF during their resuscitation. No patient with recurrent VF at any time in the field survived to hospital discharge.

TABLE 2.—*Outcome in Patients With Postdefibrillation Idioventricular Rhythm (IVR) Compared With Patients With Other Initial Organized Rhythms and Patients Without Any Organized Rhythm in the Field*

Initial Postdefibrillation Rhythm in Field	Patients, No.	Outcome: Eventual Pulses, No. (%)	Outcome: Admitted, No. (%)	Outcome: Discharged, No. (%)
IVR	49	23(47)	13(27)	4(8)
Supraventricular bradycardia	5	4(80)	2(40)	1(20)
Other supraventricular	12	8(67)	6(50)	4(33)
Unknown	3	3(100)	2(67)	1(33)
No organized rhythm	25	0(0)	1(4)	0(0)
Totals	94	38(40)	24(26)	10(11)
*P**		<.05	NS	<.025
P†		<.001	<.025	NS

NS = no significance

*Comparing IVR to all other organized rhythms.
†Comparing IVR to absence of any organized rhythm.

TABLE 3.—*Outcome Related to Subsequent Rhythm Evolution in the Field in 49 Patients With an Idioventricular Rhythm (IVR) After Defibrillation*

Rhythm	Patients, No.	Pulses, No. (%)	Admitted, No. (%)	Discharged, No. (%)
Persistent IVR	20	11(55)	7(35)	2(10)
Recurrent VF	19	5*(26)	2(11)	0(0)
Asystole	4	2†(50)	0(0)	0(0)
Supraventricular rhythm	6	5(83)	4(67)	2(33)
Total	49	23(47)	13(27)	4(8)
P‡		NS	NS	NS
P§		<.025	<.05	NS

NS = no significance, VF = ventricular fibrillation

*Includes 1 patient with pulses at the time of development of IVR.
†Includes 2 patients with pulses at the time of development of IVR.
‡Comparing persistent IVR with all others.
§Comparing recurrent VF with all others.

Discussion

The rhythms of cardiac arrest include ventricular tachyarrhythmias (ventricular tachycardia or fibrillation), bradyasystolic rhythms and electromechanical dissociation. Idioventricular rhythm is generally included with bradyasystole and EMD as a rhythm associated with a uniformly dismal prognosis. It has been our experience, however, that while only a few patients with cardiac arrest present with idioventricular rhythm, in many patients such a rhythm will develop immediately following defibrillation from VF.[4] In this circumstance, in contradistinction to idioventricular rhythm as the initial rhythm of arrest, a satisfactory outcome may be achieved, even in patients in whom such a rhythm is initially unassociated with a palpable pulse. In many of these patients a pulse subsequently develops, either while remaining in idioventricular rhythm or at the time of conversion to another rhythm. While patients having other postdefibrillation organized rhythms have an even better rate of survival, the development of idioventricular rhythm following defibrillation leaves a patient with a prognosis that is neither better nor worse than it was before defibrillation and statistically better than the prognosis for patients in whom defibrillation fails to produce any organized rhythm.

The same can be said with regard to the heart rate associated with the initial postdefibrillation rhythm: a heart rate of 60 per minute or more is clearly preferable to bradycardia; the latter, however, does not by any means preclude survival. The outcome for patients with postdefibrillation bradycardia is remarkably similar to that for all patients with VF before defibrillation and much better than that for patients failing to achieve an organized rhythm.

TABLE 4.—*Outcome Related to Prehospital Drug Therapy Given to 49 Patients With Postdefibrillation Idioventricular Rhythm Before Development of Any Other Rhythm*

Drug Therapy	Patients, No.	Recurrent VF, No. (%)	Pulses, No. (%)	Admitted, No. (%)	Discharged, No. (%)
None	9	3(33)	6(67)	5(56)	1(11)
Atropine*	29	12(41)	11(38)	8(28)	2(7)
Epinephrine*	10	4(40)	2(20)	2(20)	1(10)
Isoproterenol*	7	2(29)	2(29)	1(14)	1(14)
Calcium*	14	9(64)	6(43)	2(14)	1(7)
Totals	49†	19(39)	23(47)	13(27)	4(8)

VF = ventricular fibrillation

*Includes patients given each individual drug alone or in combination with other listed agents.
†Patients receiving various drug combinations were only counted once.

Thus, the results of early defibrillation strongly predict the outcome. Defibrillation into an organized rhythm other than an idioventricular rhythm, with a heart rate of 60 or higher, significantly improves prognosis. Defibrillation into an idioventricular rhythm or another bradycardia neither improves nor worsens predicted outcome compared with the initial VF cohort as a whole. Failure to successfully defibrillate a patient into an organized rhythm early in the resuscitation is catastrophic, leaving minimal chance for a good outcome.[4,5]

Because survival is distinctly possible following the development of postdefibrillation idioventricular rhythm, the therapeutic approach to such patients is critical. No patients in whom recurrent VF developed in our series survived to hospital discharge; any therapy given patients with a postdefibrillation idioventricular rhythm that is potentially arrhythmogenic should be considered possibly deleterious in light of this fact.

In our series patients were not treated according to a strict protocol, but we suspect that all patients with a pulseless idioventricular rhythm had prompt orders for drug therapy. We therefore suspect that the nine patients who did not receive drug therapy before another rhythm developed fell into this category only because their condition spontaneously improved or deteriorated too rapidly for drug therapy to be administered. A third of these patients degenerated into recurrent VF, whereas in the others pulses developed with or without a simultaneous change in rhythm and heart rate.

We have no idea how many patients with pulseless idioventricular rhythm following defibrillation might similarly have changed their rhythm and hemodynamic status if drug therapy had been deliberately delayed. The alternative of immediate aggressive drug therapy is not particularly attractive. Drug therapy with any or all of the standard agents recommended for the treatment of this rhythm was associated in our series with a high incidence of recurrent VF and a generally low rate of survival to hospital admission and discharge. None of these drugs are particularly benign in patients with significant heart disease. Atropine,[6-8] isoproterenol,[9] epinephrine[10] and calcium chloride[11] all dramatically increase myocardial oxygen demand and are notably arrhythmogenic. None has been independently proved to improve survival in humans with cardiac arrest from VF.[11-15]

Considering the fact that an idioventricular rhythm following defibrillation appears to be a salvageable rhythm and considering the fact that standard drugs used to treat patients with such a rhythm are potentially dangerous and seem associated with a high incidence of recurrent VF, which in our hands has been uniformly associated with fatality, we suggest that drug therapy be withheld for at least 30 to 60 seconds following development of the rhythm after defibrillation.

We recognize that this may also be associated with a high incidence of recurrent VF, although our numbers are too small to make any definitive statement. Ultimately, however, watchful waiting for a short period of time seems most likely to be safe and potentially beneficial in this situation. The prognosis remains relatively reasonable following the development of postdefibrillation idioventricular rhythm, whereas the development of recurrent VF is disastrous. Thus, avoiding the use of potentially cardiotoxic agents as long as there is a reasonable chance that they are unnecessary seems prudent.

We do not presume to know how often such a delay would lead to spontaneous improvement or how often it would result in either no change or deterioration. Using only cardiopulmonary resuscitation for 30 or 60 seconds, without drugs, would be unlikely to matter in patients who remained in idioventricular rhythm. Recurrence of VF would, of course, be deleterious, although the ability of prior standard drug therapy to prevent this in such patients is also a matter for speculation only. The possibility that antiarrhythmic therapy (lidocaine or bretylium) at the onset of postdefibrillation idioventricular rhythm might be beneficial is intriguing, considering the fact that this rhythm is generally thought to contraindicate using such agents[16]; for this reason, we would be hesitant to recommend them until larger groups of patients were evaluated.

We suspect that this extremely common postdefibrillation rhythm represents a transient stage of myocardial recovery in many patients, related to temporary suppression by the defibrillating shock of either supraventricular pacemaker activity or atrioventricular nodal conduction. We suspect that a good number of patients with idioventricular rhythm following defibrillation might spontaneously progress to a more stable rhythm and palpable pulses if treated with only external cardiopulmonary resuscitation as necessary and no drug intervention for a period of 30 to 60 seconds, and that this might reduce the risk of the development of recurrent VF associated with the use of standard drug therapy. We are currently embarked on a prospective trial to evaluate such an approach.

REFERENCES

1. Roth R, Stewart RD, Rodgers K, et al: Out-of-hospital cardiac arrest: Factors associated with survival. Ann Emerg Med 1984; 13:237-243

2. Eisenberg MS, Bergner L, Hallstrom A: Epidemiology of cardiac arrest and resuscitation in a suburban community. JACEP 1979; 8:2-5

3. Weaver WD, Cobb LA, Hallstrom AP, et al: Considerations for improving survival from out-of-hospital cardiac arrest. Ann Emerg Med 1986; 15:1181-1186

4. Warner LL, Hoffman JR, Baraff LJ: Prognostic significance of field response in out-of-hospital ventricular fibrillation. Chest 1985; 87:22-28

5. Weaver WD, Cobb LA, Copass MK, et al: Ventricular defibrillation—A comparative trial using 175-J and 320-J shocks. N Engl J Med 1972; 307:1101-1106

6. Scheinman MM, Thorburn D, Abbott JA: Use of atropine in patients with acute myocardial infarction and sinus bradycardia. Circulation 1975; 52:627-633

7. Cooper MJ, Abinader EG: Atropine-induced ventricular fibrillation. Am Heart J 1979; 97:225-228

8. Maroko BR, Kjekshus JK, Sobel BE, et al: Factors influencing infarct size following an experimental coronary artery occlusion. Circulation 1971; 43:67-82

9. Holmes HR, Babbs CF, Voorhees WD, et al: Influence of adrenergic drugs upon vital organ perfusion during CPR. Crit Care Med 1980; 8:137-140

10. Ditchey RV: High-dose epinephrine does not improve the balance between myocardial oxygen supply and demand during cardiopulmonary resuscitation in dogs (Abstr). J Am Coll Cardiol 1984; 3:596

11. Bull J, Band BM: Calcium after cardiac arrest. Anesthesia 1980; 35:1066-1067

12. Eisenberg MS, Bergner L, Hallstrom AP: Paramedic programs and out-of-hospital cardiac arrest—I. Factors associated with successful resuscitation. Am J Public Health 1979; 69:30-38

13. Pionkowski RS, Thompson BM, Gruchow HW, et al: Resuscitation time in ventricular fibrillation—A prognostic indicator. Ann Emerg Med 1983; 12:733-738

14. Weaver WD, Cobb LA, Dennis D, et al: Amplitude of ventricular fibrillation wave form and outcome after cardiac arrest. Ann Intern Med 1985; 102:53-55

15. Harrison EE, Amey BD: The use of calcium in cardiac resuscitation. Am J Emerg Med 1983; 3:267-273

16. Kuo CS, Reddy CP: Effect of lidocaine on escape rate in patients with complete atrioventricular block: B. Proximal HSS bundle block. Am J Cardiol 1981; 47:1315-1320